

Life After Large-Scale Technology Demonstrations

*Steven J. Bossart and John R. Duda
U.S. Department of Energy
Deactivation and Decommissioning Focus Area
Morgantown, West Virginia*

*William Lupichuk
Science Applications International Corporation
Morgantown, West Virginia*

ABSTRACT:

As part of the Department of Energy's Office of Science and Technology, the Deactivation and Decommissioning Focus Area is responsible for developing, demonstrating, and facilitating the deployment of improved and innovative technologies for decommissioning the Department of Energy's surplus facilities. The ultimate success of the Office of Science and Technology is tied to the deployment of superior technologies, and their associated cost reduction of the Department of Energy's deactivation and decommissioning projects, improved worker safety, reduction in radiation dose to workers, and acceleration of project schedules. Through December 1998, the Deactivation and Decommissioning Focus Area deployed thirty-two improved/innovative technologies in more than eighty instances by Department of Energy site contractors, nuclear utilities, and commercial decommissioning firms (see Table I). The number of innovative/improved technology deployments and deployment locations is expected to grow as 1) additional demonstration results are provided to the end users, 2) end users observe other Department of Energy deactivation and decommissioning projects using the innovative/improved technologies, and (3) as successfully demonstrated technologies are deployed as part of the Department of Energy's Office of Science and Technology Accelerated Site Technology Deployment Program.

INTRODUCTION AND BACKGROUND

Since late 1995, the Deactivation and Decommissioning Focus Area (DDFA) of the U.S. Department of Energy's (DOE) Office of Science and Technology (OST) has initiated seven Large-Scale Demonstration and Deployment Projects (LSDDP) [1, 2, 3] to demonstrate and deploy innovative and improved decontamination and decommissioning (D&D) technologies. In LSDDPs, innovative and improved D&D technologies are demonstrated alongside the commonly employed or

"recognized" baseline technologies as part of DOE's active deactivation and decommissioning projects. Comprehensive performance and cost data resulting from the DDFA's demonstration program, are collected on both the innovative/improved and baseline technology during the demonstration and reported via OST's Innovative Technology Summary Reports. Demonstration results provide credible information which D&D project managers can use to decide whether to adopt the innovative/improved technology as the new baseline method for completing D&D of surplus facilities.

The first three LSDDPs at Argonne National Laboratory's Chicago Pile 5 (CP-5) Research Reactor, Fernald Environmental Management Project's (FEMP) Plant 1 uranium processing facility, and Hanford Reservation's 105-C Production Reactor were completed in Fiscal Year 98 and demonstrated 56 innovative/improved D&D technologies. The next four LSDDPs at Los Alamos National Laboratory, Mound Environmental Management Project, Idaho National Engineering and Environmental Laboratory, and Savannah River Site are expected to collectively conduct 50 to 65 demonstrations of innovative/improved D&D technologies in FY99-00.

TECHNOLOGY DEPLOYMENTS

The true success of the LSDDPs is measured by the number of innovative/improved technologies deployed and the number of times they are deployed in deactivation and decommissioning projects within the DOE weapons complex following successful demonstrations, and the quantifiable benefits that the innovative/improved technologies bring to those projects in terms of cost savings, radiation dose reduction, waste volume reduction, schedule acceleration, and safety improvements. The LSDDPs are the DDFA's approach to demonstrate innovative/improved technologies in real deactivation and decommissioning projects and validate their cost and other advantages over the competing baseline

technologies. Thus, the LSDDPs provide the bridge to transition innovative/improved D&D technologies from demonstration to commercial deployment.

There are several avenues available for commercial deployment of technologies demonstrated in LSDDPs. These avenues include:

- Following its demonstration, the innovative/improved technology immediately becomes the new baseline technology, replacing the previous site baseline technology and used to complete the baseline D&D project hosting the LSDDP. The LSDDP enables improved/innovative D&D technologies to be demonstrated and deployed in the same ongoing D&D project.
- Innovative/improved technologies are included in proposals from commercial D&D firms and technology vendors, and successful bidders use the innovative/improved technologies in deactivation and decommissioning projects in DOE and the private sector, including nuclear utilities.
- The DOE site contractors use the innovative/improved technologies in their deactivation and decommissioning projects.
- The innovative/improved technologies are deployed through DOE's Accelerated Site Technology Deployment (ASTD) projects.

Select Technology Deployment Success Stories

To date, 32 of these innovative/improved technologies have been deployed over 80 times by DOE site contractors, nuclear utilities, commercial decommissioning firms, and technology vendors as a result of their superior performance compared to the baseline technologies in the demonstrations (see Table I). The number of innovative/improved technology deployments and deployment locations is expected to grow as LSDDP technology demonstration results are provided to the end users, and end users observe other DOE and private sector deactivation and decommissioning projects using the innovative/improved technologies.

The remainder of this paper will highlight several of the characterization, decontamination,

dismantlement, worker protection, and project management technologies that have been successfully deployed following demonstration in one of the LSDDPs. Technology vendor contacts are provided for more information.

Oxygasoline Cutting Torch

Petrogen International

Milton Heft

510-237-7275

The oxygasoline cutting torch system (see Figure 1) from Petrogen International consists of a 2.5-gallon fuel tank with automatic flow shutoff valve, a gasoline supply hose, and a cutting torch. Pressurized oxygen is supplied from standard oxygen bottles commonly used with oxyacetylene torches. Gasoline is delivered to the tip of the torch as a confined liquid. At the tip of the torch, the gasoline liquid expands to a vapor and is mixed with oxygen to form a combustible mixture. Mixing of gasoline vapor and oxygen in the tip of the torch eliminates back flash in the fuel line, and keeps the torch head cool.

In October 1996, the oxygasoline cutting torch was demonstrated alongside the baseline oxy-acetylene cutting torch, in the FEMP Plant 1 LSDDP. During the demonstration, each torch cut approximately 250 inches of metal components ranging in thickness from 0.5 to 4.5 inches. When cutting thick metal with the oxyacetylene torch, a portion of the molten metal tended to re-fuse and clog the area of the cut. As a result, several passes were needed to completely cut through the metal. The oxygasoline cutting torch cut cleanly through the metal in a single pass, and did not experience re-fusing problems because the gasoline flame is 100 percent oxidizing. One demonstration showed that the oxygasoline torch was able to cut through a two-inch thick steel plate in 13 minutes, whereas the oxyacetylene torch took 27 minutes to cut through the same distance on the same plate. On a 4.5-inch thick plate, the oxygasoline torch cut at a rate of 54 inches per hour compared to only 18 inches per hour with an oxyacetylene torch.



Figure 1. Oxygasoline Cutting Torch

Although the price of the oxy-gasoline torch is about \$500 to \$600 more than an acetylene torch, it is less expensive to use because it cuts faster and uses less expensive fuel. The oxygasoline cutting torch uses about \$3 per day of gasoline compared to \$32 per day for a tank of acetylene needed for the acetylene torch. The oxygasoline torch system is easier to move to other job locations because its fuel tank weighs nine times less than a standard acetylene tank. On remote job sites, regular unleaded gasoline is more readily available than tanks of acetylene. Independent cost analysis performed by the USACE indicates that the oxygasoline torch costs about 40% less per linear foot than the oxyacetylene torch for cutting one-inch thick metal. As the metal thickness increases, the cost advantage of the oxygasoline cutting torch becomes greater. For example, the oxyacetylene cutting torch cost three times more per linear foot for cutting 4.5-in thick metal than the oxygasoline torch. Payback time to offset the higher capital cost of the oxy-gasoline torch is only seven hours for cutting one-inch thick steel, and two hours for cutting four-inch thick steel.

As a result of the success of the technology demonstration, the following sites and companies have purchased and are using oxygasoline torches to size reduce metal components in their facilities: Fluor Daniel Fernald, Babcock and Wilcox, Mason and Hangar at Pantex, Argonne National Laboratory, Lockheed Martin Energy Services at Oak Ridge, LaQuilla (a major construction firm in New York City), Foster Wheeler, Lockheed Martin Energy Systems, Bechtel Hanford, Reactive Metals Incorporated, and AEA Technology PLC. The Russian Defense Nuclear Agency has purchased

over 100 torches for dismantlement of special weapons and equipment in the former Soviet Union. Additional sales are expected from other D&D firms and DOE sites.

Surface Contamination Monitor

Shonka Research Associates

Joseph Shonka

707-509-7606

The Surface Contamination Monitor (see Figure 2) from Shonka Research Associates can survey horizontal and vertical surfaces for alpha and beta/gamma contamination. The Surface Contamination Monitor consists of a position-sensitive gas proportional counter mounted on a motorized cart, which can take 400 radiation measurements per square meter. Detector arrays ranging from 0.5 to 5 meters wide are mounted on the cart. The Surface Contamination Monitor provides the operator with a real-time visual indication of the activity level on a liquid crystal display. Survey data is automatically processed with the Survey Information Management System software. The software combines data from individual strips of detectors to create a uniform grid for the survey area. The data can be analyzed using a wide range of image processing algorithms. Processed survey data can be overlaid on facility drawings. The software automatically generates data reports that meet regulatory requirements for unrestricted release.



Figure 2. Surface Contamination Monitor

The Surface Contamination Monitor was demonstrated at the CP-5 Research Reactor and Hanford C Reactor LSDDP to survey concrete floors for alpha and beta/gamma contamination. Using the Surface Contamination Monitor was about one-third the cost per square foot to survey the floor and generate reports compared to the baseline survey approach using hand-held instruments. For routine surveys and associated documentation, the Surface Contamination Monitor is about 5 to 6 times faster for beta/gamma surveys and two times faster for alpha surveys than using hand-held instruments. For free release surveys, the Surface Contamination Monitor is expected to be at least 16 times faster than hand-held instruments mainly due to its automated generation of reports.

Following the successful demonstrations in the CP-5 Research Reactor and the Hanford C- Reactor LSDDPs, the Surface Contamination Monitor has been commercially deployed at C- Reactor, the BONUS research reactor in Puerto Rico, the Hanford 108-F facility to detect plutonium, INEEL's Air Support Building, Building 301 hot cells at Argonne National Laboratory, and the Connecticut Yankee Nuclear Power Station. The Oak Ridge Institute of Science and Education is using the Surface Contamination Monitor to perform independent verification surveys for free release of facilities for both DOE and the Nuclear Regulatory Commission (NRC).

Centrifugal Shot Blast

Concrete Cleaning Incorporated

Mike Connacher

509-226-0315

The self-propelled, centrifugal shot blast system from Concrete Cleaning Incorporated propels hardened shot at high speed to remove concrete and coatings from floors. The speed of the machine and volume and size of shot control the depth of removal. The steel shot is recycled until it becomes too small to be useable. The centrifugal shot blast technology can remove concrete to within two inches of a wall junction. A High Efficiency Particulate Air (HEPA) dust collection system collects dust generated by the centrifugal shot blast technology and reduces airborne contamination.

The centrifugal shot blast system was demonstrated in the CP-5 Research Reactor LSDDP to remove coatings from the concrete floor and on the FEMP Plant 1 LSDDP to remove a one-inch

layer of concrete from the floors in Plant's 8 and 9. In the CP-5 Research Reactor LSDDP, the centrifugal shot blast had a production rate of 310 square feet per hour (sq. ft/h) compared to 200 sq. ft/h for the baseline concrete scabbling technology.

Contamination was reduced from 5,300 dpm per 100 square centimeters (dpm/100 sq. cm) to less than 1,500 dpm/100 sq. cm. Cost analysis by the U.S. Army Corps of Engineers indicated that the centrifugal shot blast technology is more economical for removing coatings than the baseline technology of mechanical scabbling for floor areas in excess of 1,900 square feet.

Subsequent to its successful demonstrations in the LSDDPs, the centrifugal shot blast system was deployed at Babcock and Wilcox NRC Plutonium/Uranium facility in Pennsylvania. The centrifugal shot blast system was also deployed by Nuclear Services Corporation to remove a one-inch layer of concrete in Plant 9 at FEMP.

Heat Stress Monitoring System

Denny Ebner

MiniMitter

(541) 593-8638

The MiniMitter Heat Stress Monitoring System (HSMS) provides real-time physiological monitoring of workers wearing protective clothing or working under conditions where heat stress or other adverse health issues are a concern. The unit displays core body temperature taken from the ear canal, skin temperature, heart rate, and motion detection on up to 10 workers at distances up to 1,000 feet away from a central monitoring station. The system is particularly useful when workers are wearing personal protective equipment (PPE) or respirators, which makes it difficult to visually observe their condition in the field. Wireless signals from the physiological monitors are transmitted to a personal computer that updates and records information on individual workers every three seconds. The system can be set to alert the work crew supervisor or safety personnel if a worker exceeds a prescribed limit for temperatures, heart rate, and motion. The worker can then be removed from the work area to prevent an adverse reaction to the stressful physiological condition.

The hot summer climate in Eastern Washington at Hanford was ideal for evaluating the HSMS. During demonstration of the system in the

105-C Reactor Interim Safe Storage Project, alarms were activated 14 times due to high heart rates and the heart rates were successfully lowered into the safe range by modifying work activities. The central monitoring station was about 100 feet away from the work area and the telemetry system was able to transmit signals through 18 inches of concrete and steel plate. The capital cost of the software, sensor units, and portable computer is about \$10,000. The system pays for itself if it prevents one occurrence of heat stroke, which can cost as much as \$16,700.

Subsequent to the demonstration, five HSMS units were deployed at C-Reactor as Interim Safe Store efforts progressed. As required, the system was also deployed at Hanford's 233-S facility. Given the value of the system, the technology is expected to be deployed at the Hanford F and DR reactors as decommissioning ramps up during the summer of '99. The DDFA has also engaged the Savannah River Site and the HSMS is expected to be deployed during continued deactivation of the 321-M facility.

LARADS

Marc Wendling
Thermo Hanford, Inc.
(509) 373-1723



Figure 3. Laser Assisted Ranging and Data System

Laser Assisted Ranging and Data System (LARADS, see Figure 3) is based on the integration of a modified auto-tracking laser system used to conduct civil surveys with a hand-held radiological detection system. Three dimensional position data and radiological survey information are recorded, sent from detector to receiving station, and then combined into electronic files to provide clear, detailed, and accurate surveys. These files are

interfaced with Geographical Information System (GIS) software to produce a myriad of reports and records. Supplementing text-type reports, survey data can be depicted graphically with color coded radiological levels overlaid on CAD drawings or on digital photographs of rooms or facility sectors. The LARADS is capable of using different kinds of radiological detectors, allowing it to be used for dose rate surveys, neutron surveys, and removable and fixed contamination surveys.

Use of LARADS yields well-documented clearance surveys of walls, floors, and ceilings of structures prior to demolition. The precision of the survey and quality of the documentation expedites regulatory review and can negate the need for questioning and confirmatory surveys. The system can be configured with large detectors on a mobile platform, which will greatly enhance productivity without compromising data quality when large surface areas require surveying. In summary, surveying with LARADS produces more useable data with greater accuracy and reproducibility with respect to locating measured activity levels. Report clarity is high and use of the equipment is relatively easy to learn. For reactor D&D at Hanford—a total of eight full-scale production reactors are to be decommissioned—LARADS has replaced the baseline method. Based on production rates, LARADS can survey 5,600 square feet in seven days compared to 10 days for positional surveys performed with the hand-held instruments with data recorded manually.

Following its demonstration and deployment at the C-reactor complex, LARADS has been deployed at Hanford's F reactor, DR reactor, and 221 B plant. LARADS has also been deployed at West Valley Demonstration Project.

VecLoader HEPA-VAC System

Vector Technologies
Brent Alexander
219-486-8867

Asbestos and other forms of insulation sandwiched between transite wall and ceiling panels requires removal and disposal during decommissioning activities. Normally, the interior transite panel was removed and workers remove and bag the insulation by hand. This work is labor-intensive because of personal protective equipment (PPE) requirements and the major portion of the work is conducted at heights greater than six feet

above the floor. In addition, full enclosures or glovebags need to be installed if the insulating material is asbestos-containing material.

The VecLoader HEPA Vacuum (VAC) from Vector Technologies is a self-contained, trailer-mounted vacuum unit that removes asbestos insulation. The VecLoader HEPA VAC transports insulation through a 5-inch diameter flexible hose up to distances of 1,000 feet. The asbestos fibers are vacuumed and captured in a fully enclosed negative pressure system and sent to a cyclone separator, where the asbestos is wetted and bagged.

Air exiting the cyclone separator is filtered through a HEPA filter system prior to discharge to the environment. The high-powered vacuum can pull asbestos insulation from walls and pipe, and is equipped with automatic safety shutoff valves.

In August 1996, the VecLoader HEPA VAC system was demonstrated in the Fernald Plant 1 LSDDP. The system was used to remove, vacuum, and bag mineral wool sandwiched between transite panels. The advantages of the HEPA VAC system over manual removal and bagging of insulation include lower airborne emissions of insulating fibers; increased productivity; less stringent PPE; improved safety; and reduction in the number of bags required due to better compaction of the insulating material. Based on results of the demonstration, the unit cost to remove insulation using the VecLoader HEPA VAC was \$1.32 per square foot of four-inch thick wall surface insulation compared to \$2.10 per square foot for manual removal which represents a 34% cost savings for the VecLoader. The VecLoader removed insulation at a rate of 68 square feet per hour per worker compared to 61 square feet per hour per worker for manual removal. Airborne samples taken during the demonstration indicated that use of the VecLoader HEPA VAC system to remove insulation resulted in airborne radionuclide levels that were 36 percent lower compared to airborne radionuclide levels measured during manual removal and bagging of insulation. Although airborne samples of insulation fibers were not collected during the demonstration, it is expected that use of the system would result in lower levels of airborne insulation fibers compared to manual bagging and removal of insulation.

Following its successful demonstration, Foster Wheeler Environmental Corporation is using the VecLoader HEPA VAC system to remove insulation in the Boiler Plant at Fernald under a fixed-price contract to decommission the Boiler

Plant. Nuclear Services Corporation is using the VecLoader HEPA VAC system to collect and bag concrete dust generated by a concrete scabbling technology under their fixed-priced contract to decontaminate and decommission Plant 9 at Fernald.

Concrete Shaver

Ian Bannister

Marcris Industries Limited

+44 (0) 1302 890888

The concrete shaver is a self-propelled, electric-powered, concrete-shaving machine that can cleanly remove concrete surfaces within extremely accurate depth tolerances. The shaver is fitted with a 250 mm by 127 mm diameter wide shaving drum, which is fitted with patented diamond impregnated blades. The number of blades utilized is dependent on the surface finish required. Low vibration levels results from the design used for mounting the blades to the rotating drum. Shaving depth is infinitely variable, ranging from 0.1 mm to as much as 13 mm. A manual rotary wheel, linked to a digital display, is used to adjust the shaving depth. In a standard setup, shaving can be achieved as close as 75-mm to corners, and with the addition of an optional side unit, concrete shaving can be as close as 15 mm from corners.

The unit weighs 150 kg (330 lbs.), has both forward and reverse actions, and consumes 16 amps of 380-480 volt 3-phase power. The system is simple to deploy, easy to maneuver, and is designed to be used with a vacuum extraction unit for dust free operation. The system operates over a wide range of traveling speeds, which yields high productivity rates compared to conventional, large area concrete removal technologies. During the demonstration at Hanford's C Reactor, the concrete shaver removed 1/8" of surface five times faster than the site's baseline scabbler.

Given the superior performance of the concrete shaver, the Environmental Restoration contractor at Hanford purchased the system and fully intends to utilize it during decommissioning of F and DR reactors. Other DOE sites which have expressed significant interest in the shaving system include the Rocky Flats Environmental Restoration Site and the Nevada Test Site. The system would be used to decontaminate large pads. Service providers, e.g., Bluegrass Concrete Cutting Inc., are also expressing an interest in the technology and may include it in their full line of services.

GammaCam and RadScan Radiation Imaging

Bill Patrie

AIL Systems, Inc.

(516) 595-5595

Mike Romero

PSC

(505) 662-4192



Figure 4. GammaCam System

Gamma ray imaging systems (2) are available from AIL Systems (i.e., GammaCam, see Figure 4), BNFL Instruments (RadScan 600 and 700), Cogema, and other manufacturers. Although each system differs slightly, in general, these systems use a sensor head that contains both a gamma ray and visual imaging system linked to a portable computer for control, monitoring, and data management. The sensor head is typically mounted on a tripod or overhead crane for stability. These systems provide a color-coded image of the gamma-ray radiation field superimposed on a black and white visual image. The colors correspond to relative strengths of the gamma-ray radiation field. The sensor head can be located from a few feet to several hundred feet from the radiation source.

The major radiation source term does not need to be in the operator's line-of-sight to use a gamma ray imaging system. These systems can image through walls, shields, doors, and other physical obstacles provided that the source is strong enough.

The AIL GammaCam was demonstrated as part of the CP-5 Research Reactor LSDDP (3) for surveying of floor and wall areas where spills may

have occurred, location of radiation sources in a large concrete vault through an opening in the shield wall, and assisting in positioning shielding around the core of the research reactor. Detailed surveys using GammaCam could be conducted at a rate of 15 square feet per minute (sq. ft/min) at a unit cost of \$0.28/sq ft compared to only 5.6 sq. ft/min and \$0.34/sq ft for manual surveys performed with hand-held instruments. The GammaCam was found to be particularly useful in identifying radiation streams from the reactor to assist in the positioning of shielding. The RadScan 600 from BNFL Instruments was demonstrated at the Hanford C-Reactor LSDDP with similar results.

Additional deployments of the gamma ray imaging technologies at Hanford include the B-Plant and the 221-U Plant. The B-Plant deployment occurred during deactivation of the facility, while the U-Plant deployment was part of a CERCLA Remedial Investigation-Feasibility Study process.

Pipe ExplorerTM

Science and Engineering Associates

David Cremer

505-880-9852

The Pipe ExplorerTM system was developed by Science and Engineering Associates to deploy a variety of survey tools to characterize the interior of pipe and ductwork. These tools include alpha, beta, and gamma radiation detectors, video cameras, and pipe locator beacons. The primary components of the Pipe ExplorerTM are an airtight membrane, a pressurized canister with membrane reel, and the detectors/camera. Pneumatic pressure in the canister causes the membrane to invert, spool off the reel, and propagate into the pipe with sufficient force to tow radiation detectors and video cameras.

To conduct the alpha measurements, a scintillation material is incorporated into the membrane. Alpha particles emitted by surface contamination of the pipe wall strike the scintillation material causing emission of light pulses, which are detected with a photodetector inside the membrane. Contamination of the radiation sensors and video camera is eliminated because they are towed inside the tubular membrane. The Pipe ExplorerTM can be deployed in pipes ranging from 2 to 40 inches in diameter and up to 250 feet long.

Alpha and beta/gamma surveys were demonstrated in the CP-5 LSDDP on 4-inch diameter drain lines, 12-inch diameter vent lines,

and 5-inch diameter fuel rod storage tubes. Based on the demonstration, the average cost to use the Pipe Explorer™ was \$34 per linear foot, although the cost varies considerably according to the complexity of the piping network (i.e., length of pipe, diameter, number of bends, pipe obstructions, and type and quantity of contamination). The baseline approach to manage buried and concrete-embedded pipe at the CP-5 Research Reactor was to excavate and dispose of the pipe at an estimated cost of nearly \$100 per linear foot.

The main value of the Pipe Explorer™ is its ability to free release buried or embedded pipe without excavating the pipe. During a demonstration at a Formerly Utilized Sites Remedial Action Program (FUSRAP) site in Adrian, Michigan, the Pipe Explorer™ saved about \$1.5 million by avoiding excavation of contaminated, buried pipe. The pipes were cleaned and surveyed with the Pipe Explorer™ to verify the pipe did not require excavation. Another demonstration at the Inhalation Toxicology Research Institute (ITRI) saved about \$500,000 by avoiding excavation of a drain line.

Following demonstrations at CP-5 Research Reactor LSDDP, ITRI, and the FUSRAP site, the Pipe Explorer™ has been deployed at Mound Environmental Management Project, Los Alamos National Laboratory, Florida Power's Crystal River Power Plant and Portland Gas and Electric's Trojan Nuclear Power Plant.

Personal Ice Cooling System

Delta Temax Incorporated

Kirk Dobbs

613-753-3996

Delta Temax is manufacturing and marketing a Personal Ice Cooling System (PICS) which reduces heat stress to D&D workers and increases stay time. The PICS is a self-contained, cooling system that uses frozen water bottles to chill water which is circulated through tubing incorporated into a lightweight, full-body garment with detachable hood, shirt, and pants. The insulated ice bottle and pump are contained in an impermeable backpack, which is attached to a harness. The assembly is worn on the worker's back or hip. The worker controls the degree of cooling using a two-speed control unit that regulates the flow of chilled water through the cooling garment. The two-liter ice bottle, circulation pump,

and suit weigh about 12 pounds. The pump is powered by three D-cell batteries which provide up to eight hours of operation. The ice bottle on PICS can be easily changed inside contaminated areas without risk to the worker, which increases stay-times almost indefinitely. The bottles can be kept frozen in an ordinary household freezer and the cooling garments can be laundered in household washers and dryers.

During its demonstration in the FEMP Plant 1 LSDDP, workers wore the PICS while scraping paint in Building 68 at Fernald. The temperature inside the building was about 105 degrees F. The average stay time for workers wearing two layers of Level C protective clothing with respirators under these conditions was about 23 minutes, while stay-times for workers wearing the PICS was four time longer. The capital cost of the PICS with Level C clothing is about \$1,600 compared to \$210 for one layer of Level C protective clothing. Based on cost analysis performed by the U.S. Army Corps of Engineers, the cost savings for a two-person crew is about \$47/hour (39% savings) for work areas with temperatures between 70-85 degrees F and \$159/hour (66% savings) for work areas with temperatures greater than 85 degrees F. These cost savings are based on a ten-hour shift, increased stay-time in the field, and cost of permanent and disposable PPE. The payback time to recover the higher cost of the PICS is 30 crew-hours of work at temperatures between 70-85 degrees F and only 9 crew-hours of work at temperatures over 85 degrees F. For each ten-hour shift at Fernald in work areas over 85 degrees F, workers wearing PICS with Level C clothing performed 5.4 hours of productive work in the field compared to only 2.3 hours for workers wearing Level C protective clothing. Following the demonstration, workers were continuing to wear the cool suits to reduce heat stress, improve comfort, and increase their stay-times.

Following the demonstration, nine PICS have been purchased and are being used by Fernald site crews performing general maintenance work, soils and groundwater remediation, and safe shutdown of facilities. INEEL is planning to deploy PICS at their site through their ASTD project.

Accelerated Site Technology Deployment Program

Recognizing the obstacles that hinder the use of effective cleanup and waste treatment

solutions, the OST has put in place the ASTD program. The program is designed to create opportunities for, and accelerate the deployment of, innovative cleanup solutions. The incentive program is part of OST's effort to bridge the gap between demonstration and deployment of systems that are faster, less expensive, and safer than current baseline technologies. Of three ongoing projects, the DDFA has one ASTD project that is deploying technologies demonstrated in the LSDDPs. This project is:

INEEL/FEMP/Argonne-East ASTD

INEEL, FEMP, and Argonne National Laboratory-East have teamed to deploy ten D&D technologies in their deactivation and decommissioning projects in 1998-2000. Seven of the ten technologies were successfully demonstrated in LSDDPs to validate their advantages over competing baseline technologies. These technologies include GammaCam from AIL Systems, Pipe ExplorerTM from Science and Engineering Associates, BROKK remote-operated demolition robot from BROKK Homshed Systems AB, concrete scabbler from Pentek, Petrogen's oxygasoline cutting torch, tire-mounted shear/grapple from EagleTech, and PICS from Delta Temax.

CONCLUSION

DOE/OST has, and continues to be, successful in catalyzing the deployment of innovative and improved technologies for cleanup of DOE legacy facilities and waste. Thirty-two D&D technologies have been deployed eighty times, largely as a result of the Deactivation and Decommissioning Focus Area's technology demonstration program. To facilitate technology deployment, the DDFA has engaged D&D entities responsible for facility decommissioning, e.g. M&I contractors, to view a technology's superior performance first hand. These superior technologies have been, and continue to be, adopted as the new

baseline for accomplishing D&D at DOE sites.

Building on this momentum, the DDFA plans to fund additional LSDDPs and ASTD projects in order to diversify the types of facilities and technology needs/problems in its LSDDP/ASTD portfolio. This approach will ensure that new D&D innovative/improved technologies will be demonstrated and deployed to address new sets of D&D technology needs and problems. In addition, the DDFA will continue to aggressively market and deploy successful innovative/improved technologies from prior LSDDPs and ASTDs to ensure their widespread deployment across the entire DOE weapons complex.

DDFA and LSDDP Web Sites

Deactivation and Decommissioning Focus Area Homepage (the CP-5 LSDDP will be made available through this website also)

www.fetc.doe.gov/dd/

Fernald Environmental Management Project LSDDP

www.fernald.gov/Technology%20Programs/lstd/lstd.htm

Hanford C Reactor LSDDP

www.bhi-erc.com/105c/105c.htm

Savannah River LSDDP

www.srs.gov/general/srtech/lstd/index.htm

Idaho National Engineering and Environmental Lab LSDDP

id.inel.gov/lstdp/

Los Alamos National Lab LSDDP

www-emtd.lanl.gov/LSDDP/DDtech.html

Mound LSDDP

www.doe-md.gov/lstd/lstd.htm

References:

1. Bossart, S. J. and K. M. Kasper, Improved D&D Through Innovative Technology Deployment, RadWaste Magazine, Volume 5, Number 1, January, 1998. p. 10-18.

2. Bossart, S. J. and R. W. Vagnetti, A Retrospective View of the D&D Focus Area's Large-Scale Demonstration Program, X-Change '97: The Global D&D Marketplace, Miami, Florida, November 30 - December 4, 1997.

3. Bossart, S.J., J. M. Hyde and R. W. Vagnetti, Bringing Innovative Technologies to the D&D Marketplace, Spectrum 98 - International Conference on Decommissioning and Decontamination and on Nuclear and Hazardous Waste Management, American Nuclear Society, Denver, Colorado, September 13-18, 1998.

Bossart, S. J. and R. W. Vagnetti, Assessment of U.S. Department of Energy's Market for Deactivation and Decommissioning Services, X-Change '97: The Global D&D Marketplace, Miami, Florida, November 30 - December 4, 1997.

Table I: Technologies Deployed After Large Scale Demonstration

Technology Name	Deployment Sites
Automatic Demolition Dust Suppression System	BHI toolbox for C/F/DR Reactors
Brokk Remote Control Concrete Demolition System	ANL-E CP-5 Reactor
Centrifugal Shot Blast	NRC plutonium/uranium facility
	Fernald Plant 9
Compact Subsurface Investigation System	Hanford C Reactor Fuel Storage Basin
	BHI toolbox for F/DR Reactors
Concrete Diamond Grinder	C-Reactor - South Water and Gas Tunnels
	BHI toolbox for F/DR Reactors
Concrete Shaver	BHI toolbox for C/F/DR Reactors
Concrete Spaller	BHI toolbox for C/F/DR Reactors and 324 B-Cell
Dual Arm Work Platform	ANL-E/CP-5
3M Empore Membrane	Savannah River Site/R-Basin
GammaCam Radiation Imaging	ANL-E/CP-5
	Wolf Creek Nuclear Operating Corp.
	Hanford's B-Plant
	Peach Bottom Atomic Power Station & Limerick Generating Station
	INEEL/TRA
	Arkansas Nuclear One
Heat Stress Monitoring System	Hanford C Reactor
	Aberdeen Proving Grounds
	Naval Health Research Center
High-Speed Clamshell Pipe Cutter	BHI toolbox for C/F/DR Reactors
In Situ Object Counting System	ANL-E/301 Hot Cell
Laser Assisted Radiation and Data System	Hanford C Reactor
	F Reactor
	DR Reactor
	West Valley Demonstration Project
	Hanford 221-B Plant
Mobile Integrated Temporary Utility System	Hanford C Reactor

	Hanford's F Reactor
	Hanford's DR Reactor
Personal Ice Cooling System	Fernald/Site Wide
Pipe Crawler	ANL-E/CP-5
	Non-DOE/Park Township, PA
Pipe Explorer	Mound
	Unit 3 at Florida Powers Crystal River Plant
	LANL
	Portland General Electric Trojan Nuclear Power Plant
Oxygasoline Cutting Torch	Fernald Plant 4 Decommissioning
	Lockheed Martin Energy System, Oak Ridge
	Mason & Hanger, Pantex Plant
	Laquila Construction Company
	Reactive Metals Inc./Envirocare
	GPU Nuclear at Three Mile Island
	Russia
	Kazakhstan
	Hanford C Reactor
	American Electric Power
	B&W Services Inc., Waterford OH
	Fernald/Bldgs. 38A, 38B, 3F, 3G
	INEEL
Reactor Surface Contaminant Stabilization	Rocky Flats/Room 3559
	Savannah River Site/Site Wide
Remote Underwater Characterization System	INEEL/TRA-660
RESRAD-Build	Hanford C Reactor Gas and Water Tunnel Piping
Rosie Remote Work System	ANL-E/CP-5
Rotopeen Scaler with VACPAC System	Savannah River Site/105-C Decontamination Bldg.
Sealed Seam Sack Suit	Hanford/site-wide
Soft Sided Waste Containers	INEEL/CFA-691
Steam Vacuum Cleaning	Savannah River Site/105-C Decontamination Bldg.
STREAM	Hanford C Reactor
	Heavy Water Components Test Reactor at Savannah River Site
	Unit 4 at Chernobyl - possibly units 1,2,3
Surface Contamination Monitor/SIMS	Hanford C Reactor
	BONUS Research Reactor in Puerto Rico
	ANL-E/ZPR & ATSR
	INEEL Air Support Bldg.
	108 F Facility at Hanford
	Connecticut Yankee Nuclear Power Station

	Oak Ridge Institute for Science and Education
	Rocky Flats Building 123
	DR Reactor
	ANL-E/301 Hot Cell
Swing Reduced Crane Control	ANL-E/CP-5
VecLoader HEPA Vac	Fernald Plant 9
	Fernald Plant 1
	Boiler Plant Decommissioning at Fernald
Wireless Remote Monitoring System	C Reactor
	BHI toolbox for F/DR Reactors
	Chernobyl Shelter Unit 4
	Cooper Nuclear Power Station
	Hanford 221-U Plant
	N Basin at Hanford